CORMORANTS AND THE GIPPSLAND LAKES FISHERY.

By George Mack,
Ornithologist, National Museum of Victoria.

Figs. 1-15.

In all parts of Australia Cormorants or Shags are condemned out of hand as pests. They are constantly harried, shoots are organized, and there is even a body of people in Melbourne whose purpose is the "sport" of organized killing of these birds. Being gregarious, the Cormorant is an easy mark when the guns are numerous, particularly so during the breeding season when adults with eggs or young in the nest must return to the rookery. All this because the Cormorant naturally seeks its food from river, estuary, lake and sea, where it and its kind have obtained their food for countless thousands of years.

It is usual, unfortunately, when matters go wrong, as when there is a diminution in a natural product, to attribute the damage to a handy culprit or supposed cause, rather than to ascertain the actual cause and take suitable action. When the commercial fishermen of the Gippsland Lakes found that the quantity of marketable fishes was decreasing, some of them saw in the presence of Cormorants the cause of their impoverishment; not a surprising conclusion, perhaps, when it is remembered that fishing is these men's livelihood, and they felt impelled, without guidance, to name a cause of their loss.

In 1938, at the request of the Department of Fisheries and Game, Victoria, it was arranged that I should endeavour to investigate the relationship of Cormorants to the fishery by an examination of stomach contents. The resident inspector of the Department at Bairnsdale (Mr. T. G. Yates) was assigned the work of obtaining the necessary specimens and I instructed him in methods of dissecting, sexing and transporting the material. As the collecting of the birds had to be done by the inspector in addition to his normal duties, which are varied and erratic as to time, he was unable to obtain as much material as I would have liked, but bearing in mind the difficulties of constant collecting and the unattractive nature of the work, to Mr. Yates and those local residents who helped him on occasion much credit and thanks are due.

Records of the annual number of men and boats employed

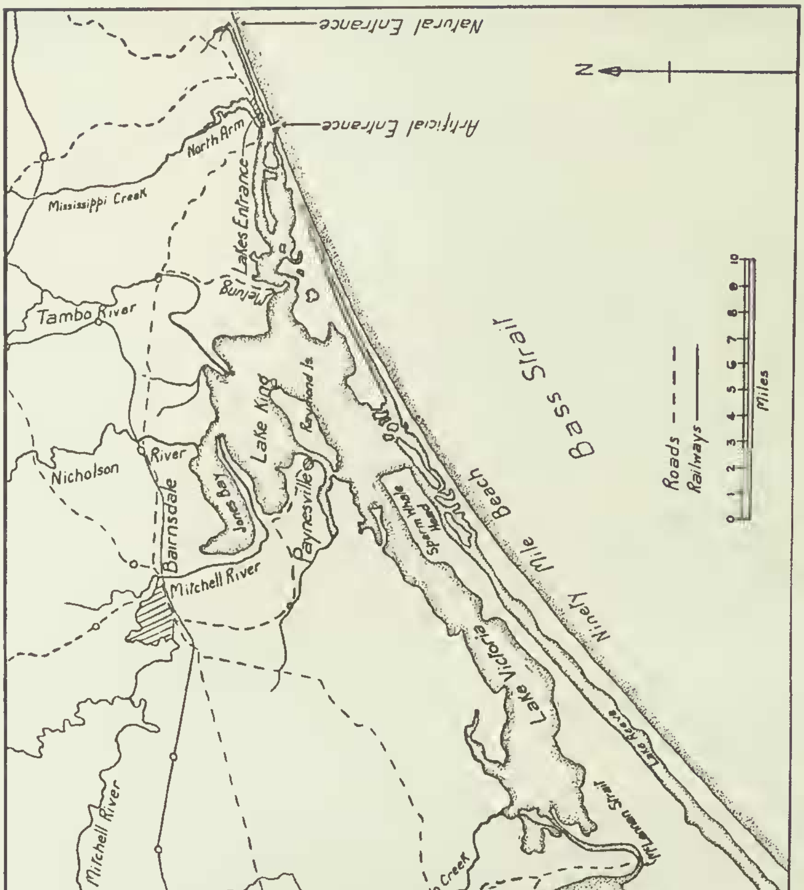

FIG. 1.

The Gippsland Lakes Area, south-eastern Victoria, Australia. G.M. del.

at, and quantities of fishes marketed from, all East Gippsland inlets were extracted from records supplied by the Department. These figures have been kept from 1911 onwards.

I should like to record my appreciation of the co-operation of many fishermen during brief visits to the lakes, and to acknowledge helpful information readily given by Mr. A. J. Gilsenan of Paynesville.

The Gippsland Lakes are situated in the plains of south-eastern Victoria, and are separated from the sea only by sand dunes. The plains consist of Cainozoic marine and continental deposits, chiefly of Tertiary age, to a depth of close on 1,500 feet as shown by bores at Lakes Entrance. Much movement and sagging has taken place in the area from Tertiary times onwards, and the formation of the lakes is due to the drowning of a relatively depressed area which includes the mouths of five major streams and some smaller creeks. The major streams, the Tambo, Nicholson, Mitchell, Avon and Latrobe rivers, drain a considerable area to the north and west of the lakes, south of the Main Divide, and are of the utmost importance to the fishery.

The area of the lakes proper is approximately 160 square miles, extending about fifty miles east and west with a maximum breadth north and south of ten miles. The western end, near which the town of Sale is situated, is about 140 miles east of Melbourne.

These lakes form the most important estuarine fishery in Victoria, and although marine fisheries using modern plant and methods may yet be developed in this State, it is probable that this area will retain its importance, providing that the fishery is preserved.

Historical.

The following brief historical outline is included here because of its bearing on the artificial entrance channel to the lakes, a vital matter to the fishery of the present.

The settlement of south-east Gippsland commenced in 1840 by penetration from the north. The desire for new pastures provided the impetus; but at that period the country in general was heavily timbered, and markets and suitable transport were lacking. About the only means of communication with Melbourne was by sailing boat, so that anything approaching fairly intensive settlement was not possible. In 1878 the railway from the capital to Sale at the western end of the lakes was opened, and from then development has been continuous. With the advent of the railway, and with steamers sailing the lakes and rivers, the fishery became a commercial proposition.

It is interesting and essential to record here that even at that period, about forty years after the first settlement, fishes were exceedingly plentiful, various species of ducks and other water birds were said to cloud the sky, and the vegetation both in and around the lakes was prolific. There is still living at least one man who, at that time, commonly shot as many as eighty pairs of ducks per day for the Melbourne market. As evidence of the abundance of fishes, the following information is taken from the third edition of a small publication by John King (Our Guide to the Gippsland Lakes and Rivers, 1886) in which he describes a visit to the lakes. The author states that on the return journey to Sale the steamer carried 10½ tons (23,520 lb.) of fishes, the result of one morning's catch. He records that one fisherman in one haul obtained 4,000 lb., chiefly Gippsland Perch (*Percalates colonorum* (Günth.)), valued at about £70-£80. Apparently Black Bream (*Sparus australis* (Günth.)) and Gippsland Perch were the main species, and another record is given of about 6,000 lb. of these two species being taken in one haul.

Although at that time the natural bar at the mouths of most of the rivers had been removed, the main sand bar between the sea and lakes was still intact, notwithstanding that between 1870-80 considerable sums had been spent in efforts to construct a permanent entrance, in order that ships of a certain draught might enter the lakes from the sea at all times. With the railway available, it is difficult to understand why this was sought, for at most only small ships of very light draught could be accommodated.

In 1881 Sir John Coode, the well-known harbour engineer, submitted a report with plans for the construction of an opening at an estimated cost of £85,700. Work according to these plans was undertaken and in 1889 the artificial channel between sea and lakes, some three or four miles west of the natural entrance, was completed. In the following years with the extension of the railway beyond Sale, the building of good roads, and the marked improvement in transport facilities generally, the use of the entrance for transport purposes diminished and finally ceased about five years ago. It may have been of some little importance to the relatively few people in the vicinity of Lakes Entrance (then Cunninghame) in the early years, but now no outside steamer calls. The channel, however, is still maintained in good order and repair.

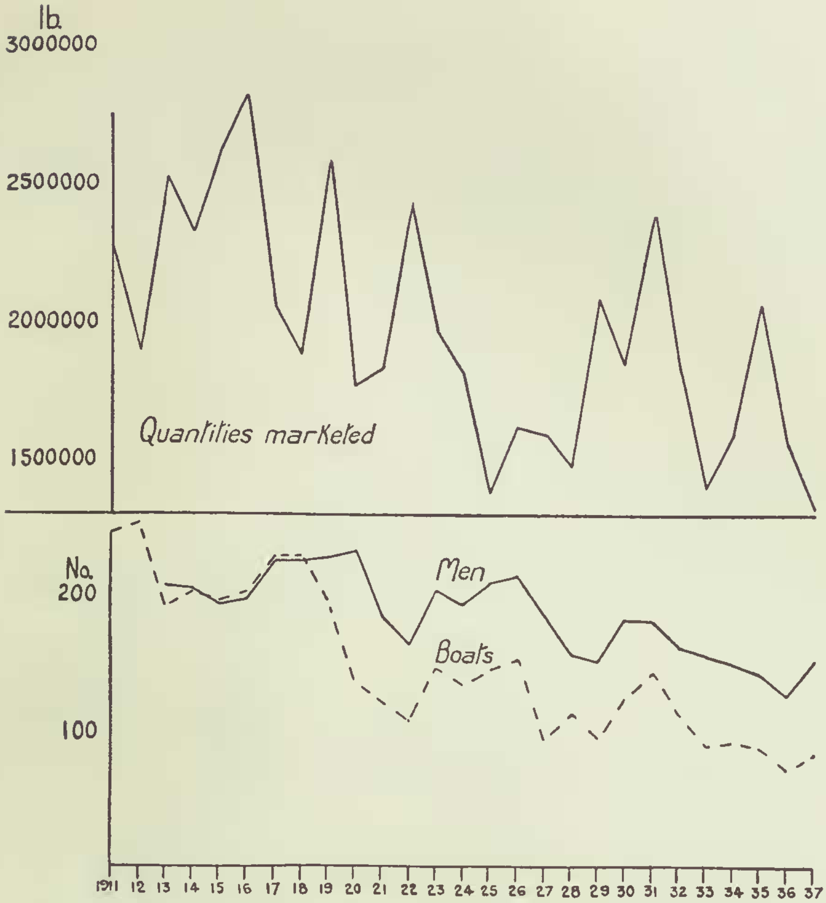

FIG. 2.
Gippsland Lakes fishery, 1911-1937. Men and boats employed and quantities of all fishes marketed annually.

Fishes Marketed.

There are twelve species of fishes of greater or less commercial importance to the fishery. These are here set down in three groups, each of which is briefly discussed in relation to the quantities of each species marketed from 1911 to 1937 inclusive as shown on the graphs. A few other species are obtained, notably Sand (Poddy) Mullet (*Myxus elongatus* Günth.), Sharks (*? Mustelus* sp.), Leatherjackets (*? Cantherines* sp.), and Kingfish (*Seriola grandis* Cast.), but the supply of these in general is erratic and the quantities such as to be relatively unimportant.

Names of fishes are according to A. R. McCulloch, *Check-list of Fishes recorded from Australia,* Memoir V, 1929-30, Australian Museum, Sydney.

1. Barracouta *Thyrsites atun* (Euphr.).
   Snapper *Pagrosomus auratus* (Bloch and Schn.).

These two species are obtained some miles to sea outside the lakes. In these circumstances, fishing is greatly controlled by the weather for only comparatively small boats are used, and this probably accounts, at least in part, for the variation in supply.

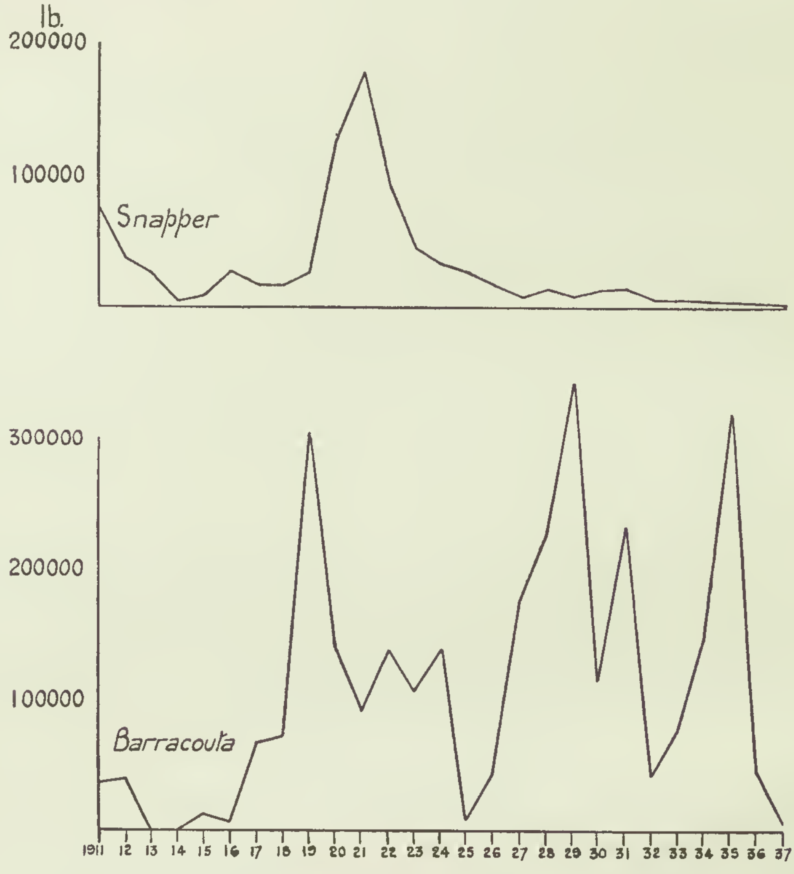

FIG. 3.
Snapper and Barracouta marketed annually from the Gippsland Lakes, 1911-1937.

The main fact in connection with this group is that neither species is in any way affected by conditions within the lakes and rivers, and are of no direct concern in any discussion of the lakes fishery proper.

2. Lake Mullet *Agonostomus forsteri* (Cuv. and Val.).
   Salmon Trout *Arripis trutta* (Bloch and Schn.).
   Trevally *Caranx georgianus* Cuv. and Val.

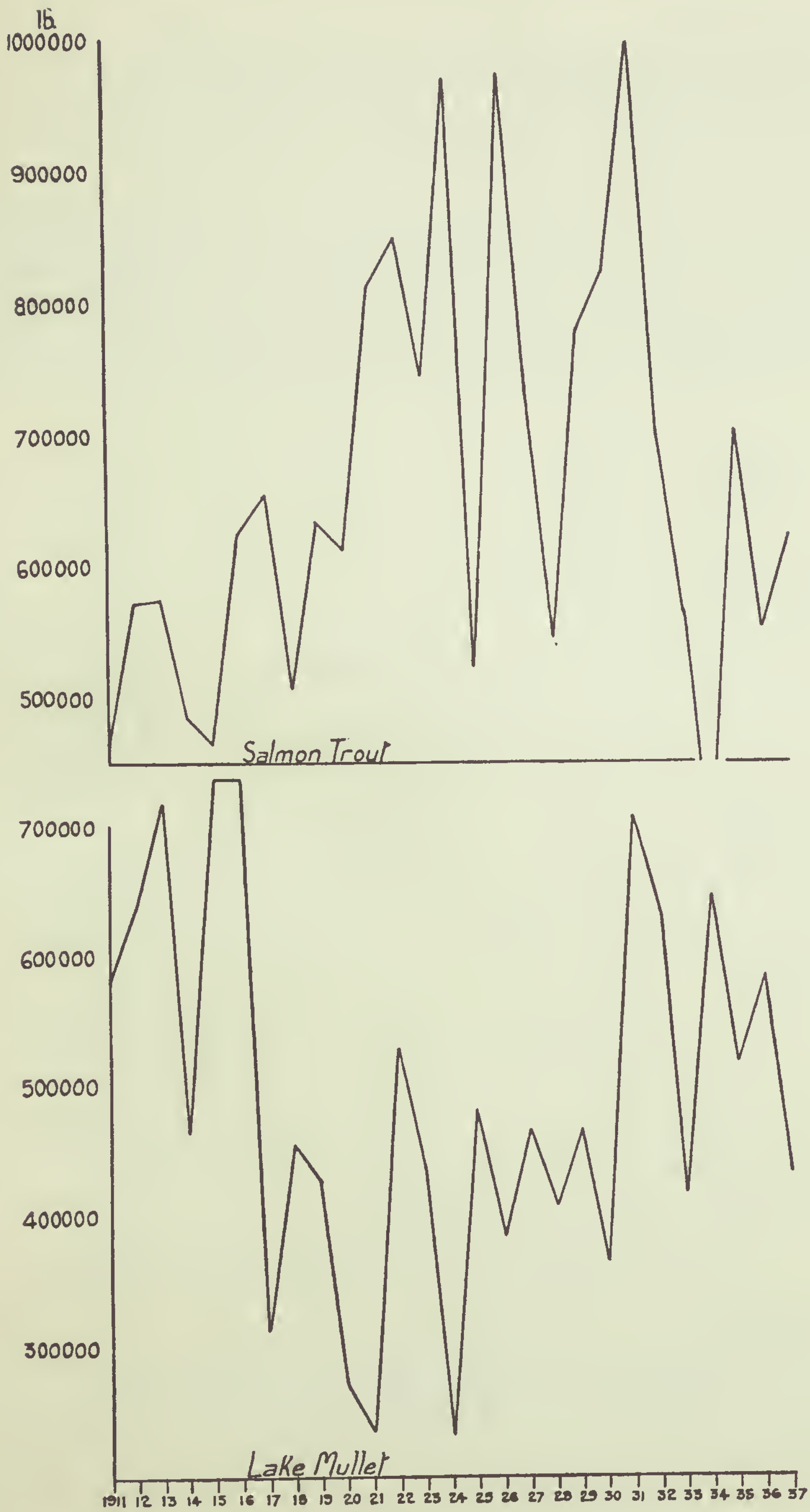

FIG. 4.

Lake Mullet and Salmon Trout marketed annually from the Gippsland Lakes, 1911-1937.

Skipjack	*Pomatomus saltator* (Linn.).
Short-finned Eel	*Anguilla australis* Rich.
Flounder, chiefly	*Rhombosolea tapirina* Günth.
Sand Flathead	*Platycephalus bassensis* Cuv. and Val.

The above seven species are netted in the lakes, but so far as is known, none of them spawn in the lakes or rivers. This being the case, and the statement is made with considerable assurance, it will be evident that they are independent of the conditions in the estuary at the most critical period of life.

In quantity, Lake Mullet and Salmon Trout are out-

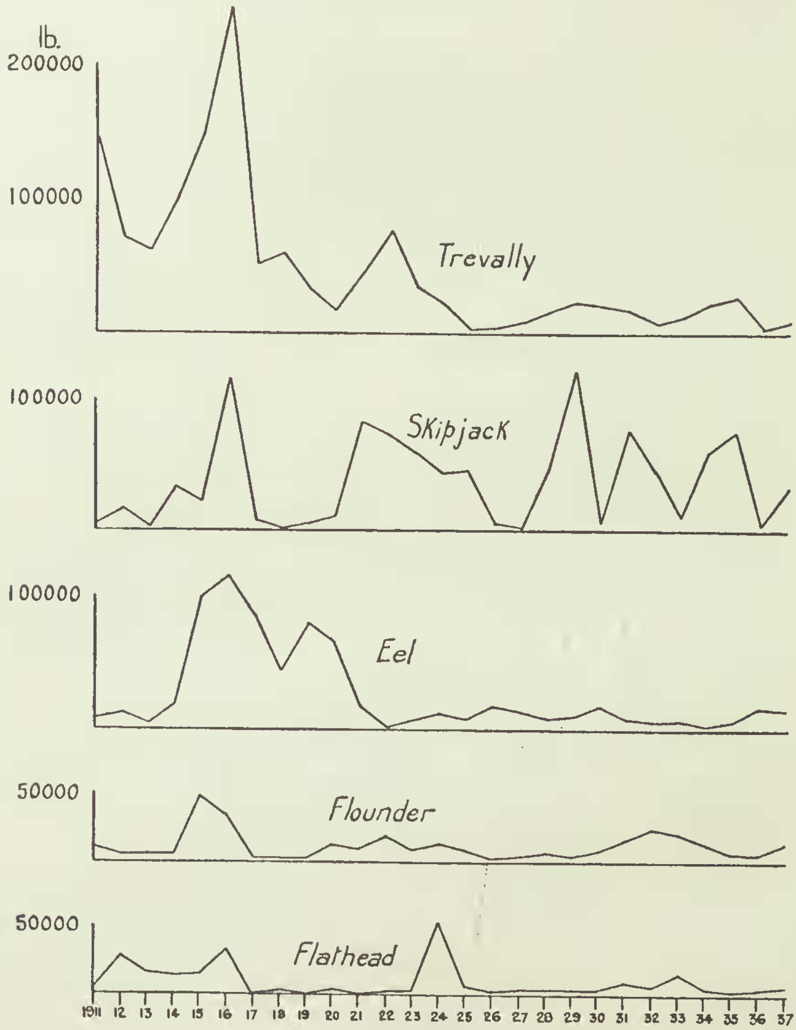

FIG. 5.

Five species marketed annually from the Gippsland Lakes, 1911-1937.

standing, and there has been no diminution during the period for which figures are available. Amounts of the other five species have never been large and the graphs show fairly usual variation but no marked reduction except in the case

FIG. 6.
Black Bream marketed annually from the Gippsland Lakes, 1911-1937.

of Trevally. It may be noted that all show a decided rise in 1916, a record quantity of two species. This was a year of extreme flooding in rivers flowing into the lakes and there is here, obviously, a direct connection between the effect of great volumes of fresh water and the numbers of the species of this group entering the lakes from the sea.

3. Black Bream — *Sparus australis* (Günth.)
River Garfish — *Hyporhamphus regularis* (Günth.)
Ludrick — *Girella tricuspidata* (Quoy and Gaim.).

Although details of the spawning of any of the fishes mentioned in this paper are unknown, there is considerable evidence indicating that the three species of this group are wholly dependent upon the lakes and other similar inlets from the egg stage to maturity. This is a very important point, for it will be apparent that any marked alteration in the natural condition of the lakes will seriously affect these fishes. The graphs show that the diminution in the supplies

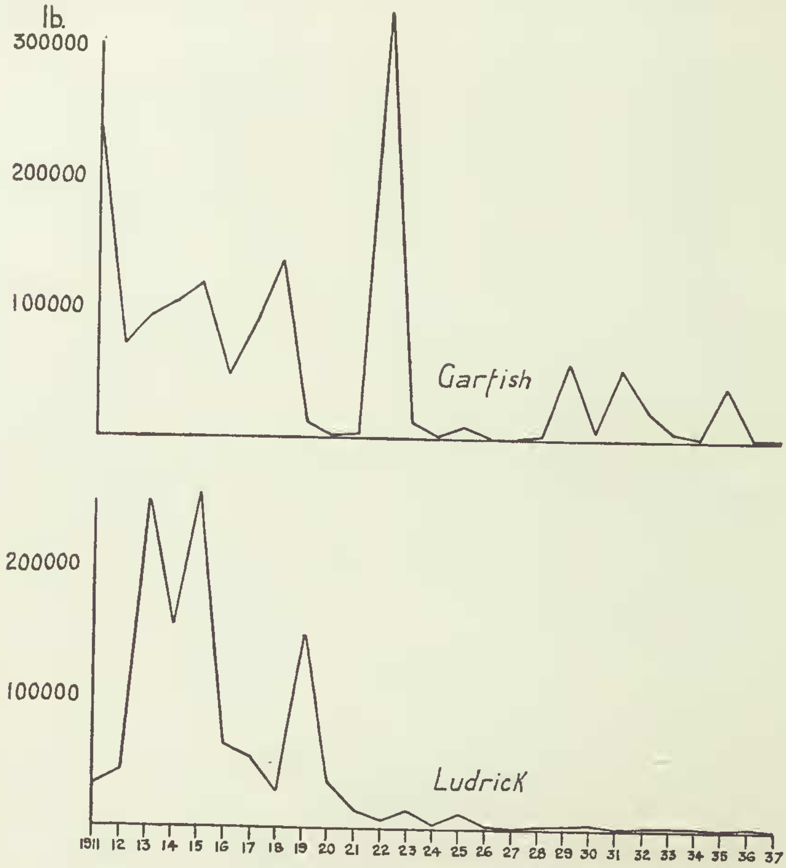

FIG. 7.
River Garfish and Ludrick marketed annually from the Gippsland Lakes, 1911-1937.

of this group is mainly responsible for the reduced total annual quantity, and moreover, the choicest fish of the lakes, the Black Bream, has been most affected in this respect. The Bream occurs in the diet of the Large Black Cormorant

(*P. carbo*), but I do not consider this even to be a contributing factor. Conditions in the waters of the estuary are the dominant factors in the case of species whose whole life-cycles are completed within the area. This matter is referred to more fully following a statement of the results of Cormorant stomach examinations.

With regard to the spawning of fishes there is an aspect which, although elementary, might well be restated here because of its great importance to a proper appreciation of economic work. A female fish in spawn produces a large number of ova or eggs. The number varies with the species, and in some instances runs into millions from one fish. It will be apparent that if all fertilized ova reached maturity, in a very brief time fishes would be so numerous as to make life in the sea impossible. Perfect natural interlocking controls prevent this, and even in those species in which a single female produces millions of ova, on the average, only two attain maturity and spawn, thus maintaining but not increasing the numbers of any one species. The remainder in general are eaten by other organisms either as eggs or at some stage before reaching maturity. Probably the least among the many natural controls are various species of birds, and the common attitude of many people that because a certain kind of bird feeds partly or entirely on fishes it is of necessity a harmful species, is entirely wrong and indefensible. This is an indication of what is intended when it is stated that under natural conditions a natural balance or equilibrium, is maintained.

Stomach Examination Results.

Of five species of Cormorants or Shags occurring in Australia, four are known from the Gippsland Lakes. They are as follows:—

Large Black	Cormorant	*Phalacrocorax carbo novaehollandiae* Steph.
Small Black	,,	*Phalacrocorax sulcirostris* (Brandt).
Yellow-faced Pied	,,	*Phalacrocorax varius* (Gmel.).
Small Pied	,,	*Microcarbo melanoleucus* (Vieill.).

Outstanding in size and numbers is the Large Black, the species with which this paper is concerned. Next in numbers is the Small Pied, followed by a more meagre population of the Small Black, and finally a very few Yellow-faced Pied.

It is possible that the fifth species, the Black-faced Pied (*Phalacrocorax fuscescens* (Vieill.)) occurs as an occasional visitor, but so far no specimen has been taken.

It was obvious from the beginning that only the Large Black and Small Pied were likely to be of any importance to the work in hand, the other two being too few in numbers to warrant consideration. Soon after the examination of stomach contents was commenced it became apparent that the Small Pied also was of no consequence in so far as edible or marketed fishes were concerned. Thus the collecting and examination of the Large Black Cormorant received most attention and no other species is included in the results that follow.

It is necessary to make clear that the Cormorant populations on the lakes are not permanent throughout the year. The first record of any species nesting in the area was made in 1939 when, I am informed, a small rookery of Yellow-faced Pied was discovered. All other species apparently leave the lakes for breeding, and therefore are present in considerable numbers during only a part of the year.

For the purpose of this investigation I should like to have obtained about 25-30 specimens of the Large Black Cormorant per month throughout the year. This number would have given a very good cross-section of the food, and it is what was aimed at but not quite attained. However, more than 200 stomachs of the Large Black alone were examined, and practically all were collected during the six months when the birds are most numerous on the lakes. During the three months November, December, January, when no specimens were obtained, the number of these birds on the lakes must be negligible.

The volumetric or percentage by bulk method is employed here to record the stomach contents. This involves the determination and sorting out into separate masses of the different species of organisms present in any one stomach. This completed, the smallest mass is taken as a unit and from it the volume percentage of each species of organism is determined. It is the method adopted by the majority of workers, and has been used consistently by the Bureau of Biological Survey of the United States Department of Agriculture, the work of which, both in amount and execution, is outstanding.

A few workers, including D. L. Serventy in a recent paper (*The Emu,* xxxviii, 1938, pp. 293-316) use the numerical method. Essentially this consists of counting and recording the number of individuals of each species of organism in each stomach, quite irrespective of size. For instance, the stomach of a Large Black Cormorant will be distended, more than full, with one Black Bream (marketed) measuring 240 mm. (9½ in.) in total length, and another similar stomach may contain when full about 70 Anchovies or Gobies (non-marketed). By the numerical method as employed by Serventy this would be as 70 to 1 in favour of the non-marketed form and therefore in favour of the Cormorants, whereas by the volumetric the result would be as 1 to 1. Because of the general disparity in size between marketed and non-marketed fishes, the numerical method tends to favour the case for the birds, but above all, it signally fails to give any proper conception of the part played by the different kinds of organisms in the birds' diet. On the other hand, the volumetric method does provide this information. The counting of individual organisms may be used with advantage to stress a point, and throughout this work a count has been made for the purpose of helping to interpret the percentage results.

This matter has been discussed at some length since very little of this kind of work has yet been done in Australia, and it is a matter for regret that I find myself unable to accept as a working basis the numerical method as recently used by Serventy. The various methods of estimating the stomach contents of birds are ably discussed by W. L. McAtee in *The Auk,* xxix, 1912, pp. 449-464.

The results of stomach examinations of the Large Black Cormorant for each month of 1939 for which material was received is set out below, with diagrams showing the volume percentage of each food species. Almost without exception the birds were collected during the afternoon and early evening.

In addition to the marketed fishes already named, the following species of non-marketed fishes and crustacea occur in the results. Only the common names are used in the text and diagrams, and it will be noted from the list that the term Gobies covers three species of these small fishes which were easily separated in the stomach contents, but separate treatment here does not seem warranted.

Fishes—

Anchovy *Engraulis australis* (Shaw).
(The "Smig" of the fishermen.)

Gobies	*Gobius lateralis* Macl., *G. bifrenatus* Kner, and *Mugilogobius galwayi* McCull. and Waite.
Hardyhead	*Atherina microstoma* Günth.
Sprat	*Hyperlophus vittatus* (Cast.).
Gudgeon	*Philypnodon grandiceps* (Krefft).
Galaxias	*Galaxias attenuatus* (Jenyns).
Cobbler	*Gymnapistes marmorata* (Cuv. and Val.).
Lamprey	*Caragola mordax* (Rich.).
Crustacea—	
Crab	*Paragrapsus gaimardii* (M. Edw.).
Prawn	*Leander intermedius* (Stimp.).

February.—Sixteen stomachs received of which eight were empty.

The birds were very scarce, and probably the few present had just returned from breeding, for those collected were in poor condition.

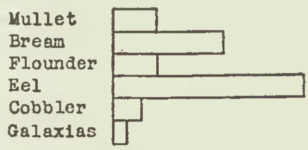

FIG. 8.

February diet; percentage volume of each food species.

The common Short-finned Eel, which is not a food fish of any importance, formed the largest single food item. Two stomachs each contained a single small Bream.

It was recorded that there were "plenty of small Bream about" where some of the birds with empty stomachs were collected.

March-April.—Eight stomachs received of which five were empty.

There was no food fish in the three effective stomachs. One contained 60 per cent. Gobies and 40 per cent. Hardyhead, and two 100 per cent. Gobies.

During these two months the Large Black Cormorant population continued very small, which partly accounts for the small number received. In general the birds were in poor condition and each day they were seen to return to their roosting trees inland from the lakes from 2.30 p.m. onwards. Some of these birds going to roost early were found to have empty stomachs, which is surely remarkable. It appears to me as indicative of the great difficulty experienced by the Cormorants in catching the average swift-moving food-fish, even when the latter is small.

May.—Sixty-one received of which twelve were empty.

The empty stomachs were forwarded merely as examples of many shot in this condition either while roosting or going to roost in the early afternoon.

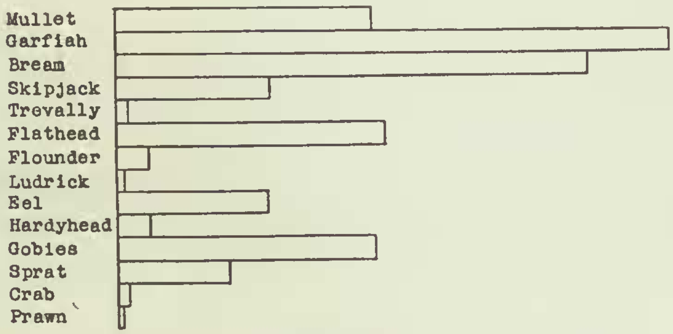

FIG. 9.
May diet; percentage volume of each food species.

Early in the month the birds still were not plentiful and it was remarked, "I do not think there are more than about one thousand birds [Large Black] on the lakes at present." Towards the end of May, however, the number increased considerably. It would appear from the results that because of this increase and the fact that their main food item (Anchovy) was not then available, food fishes entered into the diet to a greater extent than at any other period. The all-important Bream forms about 25 per cent. of the total. The number of effective stomachs received was greater than for any other month.

June.—Thirty stomachs received of which five were empty.

The appearance of the Anchovy in the lakes is reflected in the food diagram. Of fourteen out of fifteen stomachs in

FIG. 10.
June diet; percentage volume of each food species.

which this species occurred it represented 100 per cent. of the contents. Bream was present in three examples, representing only 2·94 per cent. of the total stomach contents.

The number of birds apparently reached its height in June, thus synchronising with the arrival in the lakes of the Anchovy.

July.—Twenty-nine effective stomachs received.

The Anchovy is still the largest single item of diet. Bream forms 8·20 per cent. of the total.

The birds continued to return in numbers to roost from 2 p.m. onwards each day. Many more than twenty-nine were shot but those having empty stomachs were not forwarded to me.

It is worthy of note that towards the end of July some birds were assuming the patches of white on the ventral surface characteristic of the breeding plumage in this species.

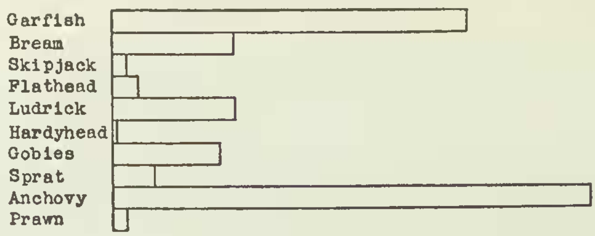

FIG. 11.
July diet; percentage volume of each food species.

August.—Fifteen stomachs received of which one was empty.

Anchovy again exceeds any other single item. Indeed, it is double the total of all other food species. Bream (1) forms 1·05 per cent.

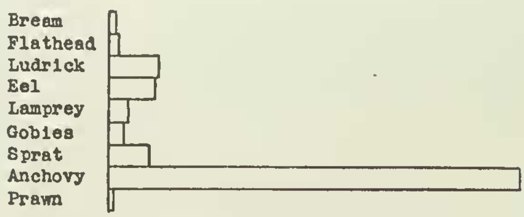

FIG. 12.
August diet; percentage volume of each food species.

September.—Forty-three stomachs received of which eleven were empty. I have added here, however, six specimens examined in September, 1938 making an effective total of thirty-eight.

Anchovy continues to be the largest single item, but Gobies, Gudgeon, Hardyhead and Sprat form a considerable portion. During this and the following month the first three of these last named small fishes were in spawn and they were probably taken on or near their spawning ground. Six stomachs each contained a single Ludrick, which accounts for the prominence of that species in the diagram. Bream forms 5·24 per cent. of the total.

The condition of the birds at this time was excellent, each stomach being coated with fat to a depth of 10-15 mm. This may reasonably be attributed to the oily nature and high food value of their main items of diet, commencing with Anchovy and passing on to Gobies and other small fishes. Many more birds now had assumed the white plumage patches on the ventral surface first noted in July, and most of those collected showed enlarging gonads.

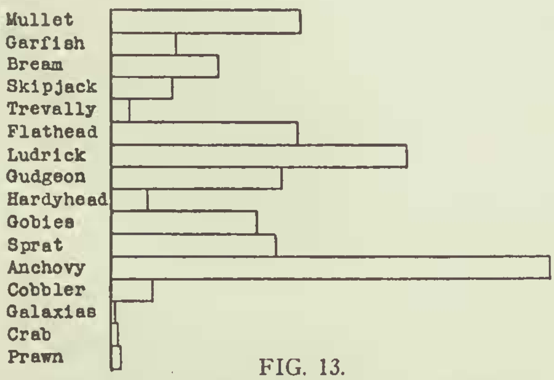

FIG. 13.
September diet; percentage volume of each food species.

October.—Fourteen effective stomachs received.

It is apparent from the results for this month that the Anchovy must have left the lakes about the end of September.

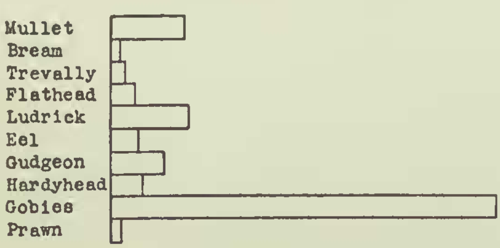

FIG 14.
October diet; percentage volume of each food species.

The Gobies are the chief food item for October and, as noted above, these small fishes were in spawn. Bream forms 1·38 per cent. of the total.

By the end of this month the birds were leaving for their breeding area. It is probable that some had previously gone and that their departure from the lakes takes place over a period similar to their return. I am informed that examples were so scarce as to be practically unprocurable during the next three months, and I can testify that in the course of a few days spent in a section of the area towards the end of January this year (1940), no single Large Black Cormorant was seen.

From the foregoing results alone it will be evident that the depletion of some marketed fishes cannot legitimately be attributed even to the Large Black Cormorant, the most condemned of all species.

During the period when the birds are present on the lakes in greatest numbers a large part of their food consists of Anchovy or Smig, Gobies, Sprat, and other small fishes. It should be noted that the marketed fishes included in the diet comprise both those of which the annual quantities have declined and those which in fact have increased. Of the two species which are outstanding in amounts marketed, the Lake Mullet occurs fairly commonly in the diet, while not one Salmon Trout was found in any stomach examined. It is possible that the latter species enters the lakes only at a late stage of maturity.

Bream forms about 8 per cent. and Anchovy 25 per cent. of the grand total.

Summary

It is remarkable how frequently a particular kind of bird is named as a cause of the destruction of another group of animals or plants. Yet it must be admitted, although it is apparently seldom realised, that previous to settlement in a country such as Australia, both indigenous animals and plants were far more numerous and, what is more important, coexisted in perfect harmony since all are directly or indirectly interdependent.

There is ample evidence that in the Gippsland Lakes area all forms of life, including Cormorants and fishes, were much more plentiful previous to widespread settlement than is the case to-day. Therefore the problem is not just a matter of what constitutes the Cormorants' food, but of what has caused such obviously unbalanced conditions as seriously to reduce the numbers not only of fishes but of Cormorants and other forms of life. Man alone is the culprit, but with him also lies the counter if action is taken in time. This is a much wider field, and lacking necessary facilities, was beyond what could be accomplished in detail, but at least some aspects could not be ignored.

The graphs of quantities show that there has been a marked decrease particularly in three species of fishes which, unlike the other marketed fishes, appear to be entirely dependent upon the estuary throughout life. In the natural state the waters of the lakes were chiefly fresh to brackish, with increasing salinity only towards the entrance. These conditions were maintained by a natural sand bar between the lakes and the sea which was cast aside when flood waters entered the lakes from the rivers, and mechanically piled up again when the flow was normal, thus at all times keeping the condition of the waters constant. There were similar bars across the mouths of all streams entering the lakes.

Aquatic plants, chiefly grasses, were plentiful, and it is known that the Ludrick feeds on some of these plants, and that they furnish a necessary environment for much of the animal life upon which Bream and River Garfish feed. It is probable too that the aquatic grasses are an essential part of the spawning grounds of all three species. Although so important a link in the chain of vital factors, it was impossible to make a survey of the aquatic vegetation, but as an indication of what appears to be happening, the effect on one of the largest and most common of the plants, the Streaked Arrow Grass (*Triglochin striata* Ruiz.), may be cited as an example. This is a swamp grass which lives in fresh to brackish water, but apparently cannot exist for long in salt water. If, then, an artificial entrance permits the sea to flow freely into the lakes, it may be expected that this and other similar plants will be seriously affected if not destroyed, and if such plants are of considerable importance to the well-being of fishes dependent upon conditions within the lakes, the fishes in turn will be similarly affected if not destroyed. At present the waters of the lakes and for a considerable distance in the rivers are described as being "as salt as the sea." The general effect on the Streaked Arrow Grass has been to destroy practically all growth above bottom level, only the root system remaining. Apparently if flooding is not too long delayed, the root system will survive and fresh growth will be given off. Should the floods be of short duration any new growth will soon again be killed. This is what would appear to be taking place in the Gippsland Lakes, although probably in a much more complex manner with more serious results than I have indicated. I am informed that the Streaked Arrow Grass can be obtained at the moment (July, 1940) only in a few favourable localities.

With the completion of the artificial entrance in 1889 the more or less constant composition of the waters was destroyed and, as a consequence, the very basis of the natural conditions of the lakes. There is no available written evidence of the effects in the early years, and no record of fish quantities until 1911, but the process would be a gradual one, successfully held in check at times by floods. The greater and more frequent the floods the less the possibility of deterioration by the free access of sea water. The most beneficial year in this respect was 1916, when flooding was severe and prolonged with interesting results as shown in the graphs of quantities.

Towards 1920, however, the effects of what can only be attributed to increased salinity were becoming increasingly evident. Depletion of aquatic grasses was noted, and what was of more immediate concern to the fishermen, by that time a crab (*Paragrapsus gaimardii* (M. Edw.)) had multiplied to such an extent as to make the use of mesh nets impossible. No sooner were the nets put out when they were attacked and destroyed by enormous numbers of these crabs. Until then the sunk or mesh net was one of the main methods of fishing; it is not now used except occasionally during flood periods. The presence of this crab in such numbers almost certainly has resulted from the increased salinity of the lakes making conditions suitable for them, and the lack of natural controls or opposition has permitted their increase to such an extent that they are now a serious pest.

From about 1920 onwards the fishery has deteriorated. For instance, the marketed quantity of Bream for the year 1919 was more than 700,000 lb.; in 1929 it was 50,000 lb., a drop of approximately 93 per cent. in ten years. The highest figure since 1919 is 250,000 lb. in 1935, a drop of 64 per cent. To attribute this marked decrease to the depredation of Cormorants is merely to avoid the issue. A reference to the graphs will show that the Ludrick, which is completely dependent on vegetation as food, has been so reduced as to be non-existent from the commercial viewpoint. Another significant fact is that the Gippsland Perch was netted in the lakes and marketed as commonly as Black Bream in the early years. To-day it is practically absent from the lakes; a very few are obtained occasionally after floods. The explanation is that the Perch is essentially a fresh-water fish. Furthermore, in a few similar though smaller inlets to the east of the Gippsland Lakes there has been no downward trend in the annual quantities of Bream and other species obtained. This is shown on the accompanying graphs. At these inlets the natural bars to the entrances have not been interfered with, and the result is there is no

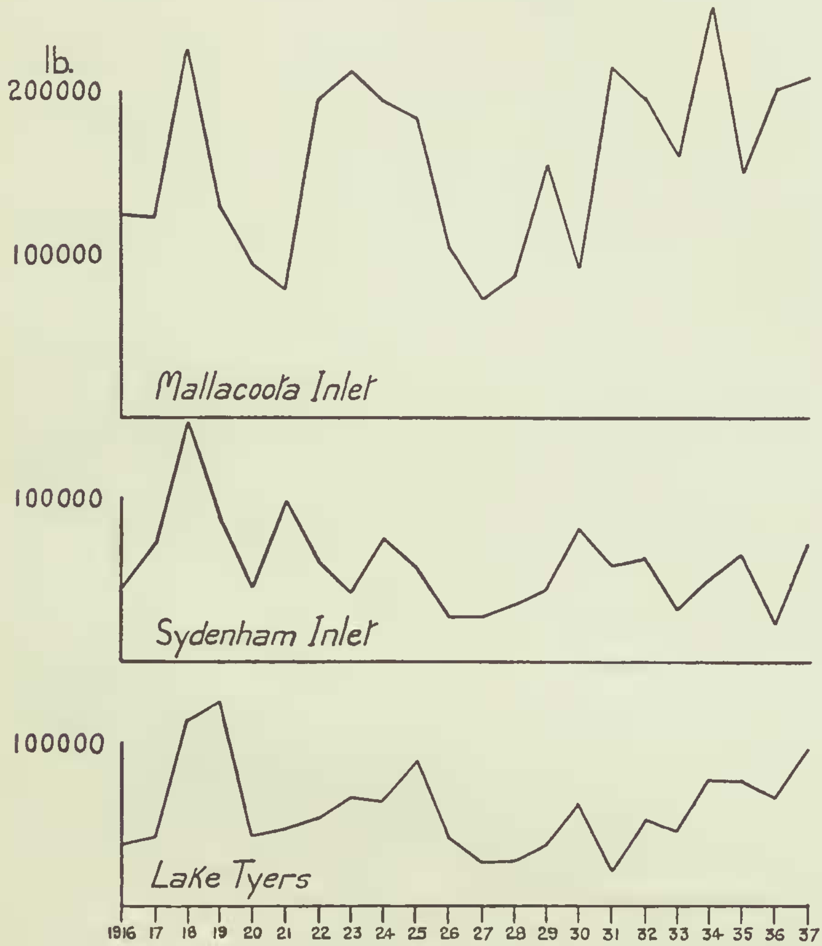

FIG. 15.
Fishes marketed annually from three East Gippsland inlets, 1916-1937; total quantities.

crab pest and aquatic plants still flourish, thus affording food, food harbourage, and probably suitable spawning areas for the fishes.

The fact that the productiveness of these inlets is unimpaired effectively refutes the suggestion that fishermen's nets have destroyed the aquatic grasses in the main lakes; the other popular idea, that the crabs are responsible, may be safely set aside.

The possibility of over fishing and the increased facility of movement afforded by motor boats have been suggested as contributing factors, but the evidence does not support this. While the use of the motor boat has aided the fisherman it has also added to his expenses, and it should be noted that the number of men engaged went down by about 25 per cent. during the ten years prior to 1937. This reduction in numbers followed the marked diminution in fish quantities which coincided with, and appears to have resulted from, the increased salinity over a period, causing the destruction of the aquatic grasses and the advent of the crab pest in the lakes. A fisherman must obtain a licence for himself and his boat each year, and there are regulations to which he must adhere, notably the prohibition of netting in rivers and specified areas at the mouths of rivers. These points are mentioned as evidence that proper control is exercised over those engaged in the fishery.

Other factors, such as the unnecessary clearing of land, uneconomic settlement generally, and the destruction of forests in the watershed by fires and other means leading to increased erosion, doubtless have contributed to the deterioration of the fishery, but the evidence available appears to me to indicate that the basic cause of the difficulties affecting the Gippsland Lakes Fishery is the permanent artificial entrance. If this entrance was used for the benefit of some other industry there would perhaps be a case to answer, although I am doubtful if any other industry could compete in value with a good estuarine fishery which only requires intelligent working to be permanent and constant in supply.

I have endeavoured to show that neither the Cormorant nor any other particular organism (aside from man) is responsible for what is taking place in the Gippsland Lakes. The Cormorant and every other group or kind of organism (animal and plant), from the microscopical to the largest, are essential parts of a whole. Under natural conditions all of these so fit in and react one with another that, no matter what the climatic or other conditions may be, equilibrium—a natural balance—is maintained. But let any one or any body of people interfere to destroy any single unit of this whole, and the result is likely to be disastrous. This result may be long delayed, but it is none the less certain. It cannot be otherwise, for the natural laws which govern these associations of animals and plants are immutable. There is ample evidence of this destructive interference throughout Victoria alone, and so long as we continue in our ways, tinkering occasionally with effects instead of dealing with causes, so long will we continue to reap disaster for ourselves and those who follow. There is only one way out and that is to seek to know intimately these natural conditions or laws, and to work with, not against them. This information can be obtained only by means of thorough ecological surveys the cost of which would be equal to an infinitesimal portion of what is at present lost annually through a lack of such work.